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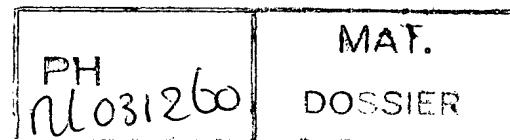
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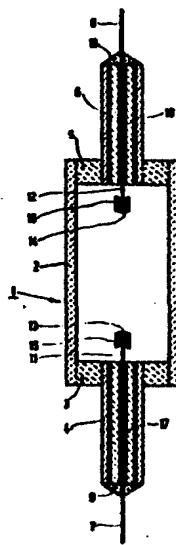
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㉚ High-pressure mercury vapour discharge lamp.

㉛ High-pressure mercury vapour discharge lamp having a discharge vessel of gas-tight radiation transmitting ceramic material, provided with a filling comprising a rare gas, mercury, sodium halide and thallium halide. The wall load (power consumption divided by the surface area of the outer wall of the discharge vessel) has a value of at least 25 W/cm². The ratio between the effective internal diameter ID of the discharge vessel and the spacing EA between two electrodes has a value in the range of 0.4 ≤ ID/EA ≤ 0.9.



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"High-pressure mercury vapour discharge lamp".

The invention relates to a high-pressure mercury vapour discharge lamp having a given power consumption during operation, provided with a discharge vessel having a wall of gas-tight, radiation transmitting ceramic material, said discharge vessel enveloping a discharge space and being provided with an ionizable filling comprising a rare gas, mercury, sodium halide and thallium halide, an electrode being disposed within said discharge vessel in the proximity of each of two end wall parts, 5 the electrode tips facing each other being located at a mutual distance EA.

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A lamp of this type is known, for example, from United States Patent Specification 3,363,133 showing a discharge vessel of ceramic material, namely densely sintered polycrystalline aluminium oxide. In addition to mercury and a halogen, the known lamp comprises one or 15 more metals such as thallium and furthermore it may comprise an alkali metal, for example, sodium.

The addition of metal halides, in most cases 20 metal iodides, to the ionisable filling of a high-pressure mercury vapour discharge lamp is a step that has been used for quite some time in lamps having a quartz glass discharge vessel. Its object is to obtain a higher density of metal atoms in the discharge space by utilizing the greater 25 volatility of the metal halides as compared with that of the metals themselves, and hence a greater contribution of the metals to the radiation emitted by the lamp. This results in an improvement of the relative luminous flux and particularly also the colour rendition of the lamp.

30 Alkali metals such as sodium and lithium are used in a halide form because these metals themselves are too aggressive relative to the quartz glass wall of the discharge vessel.

In lamps containing metal halide the halide pressure is determined by the temperature of the coldest spot T_{kp} within the discharge vessel. The maximum admissible value of T_{kp} is limited by the material of the discharge vessel. In the case of quartz glass discharge vessels T_{kp} may not be more than approximately 800°C . It has already been recognized at an early stage that the use of materials for the wall of the discharge vessel which can be subjected to a higher thermal load may lead to higher halide pressures. United States Patent Specification 3,234,421 already states the possibility of using densely sintered aluminium oxide as a material for the discharge vessel.

A halide filling which is frequently used in quartz glass lamps consists of the halides of thallium and sodium to which mostly indium halide is added. Experiments have shown that as compared with the quartz glass lamps an improvement is obtained concerning the relative luminous flux and also to a very slight extent the colour rendition if such a filling is used in a ceramic lamp vessel as stated in the above-mentioned United States Patent Specification 3,363,133. Such a lamp has, however, some great drawbacks, so that its practical use is not very well possible. In the first place the colour rendition is still insufficient for many uses and furthermore these lamps have among themselves a strong spread in their colour point and a variation thereof during their lifetime. Secondly it is found that the colour point of these lamps is greatly dependent on variations in the power consumption of the lamp. These variations are the result of mains voltage variations that cannot be avoided in practice.

United States Patent Specification 3,334,261 mentions lamp fillings comprising halides of rare earth metals. It has been found that lamps having a satisfactory colour rendition are possible particularly with Dy, Ho, Er, Tm and/or La. A drawback of these lamps is that they have a high colour temperature (4000 K or higher). For practical uses a lower colour temperature is often very

much desired. If the colour temperature in these lamps is to be decreased, the use of sodium halide is generally required which must be used in comparatively large quantities. This results in a great decrease of the contribution of the rare earth metals to the radiation emitted by the lamp so that the colour rendition of the lamp is adversely affected.

It is an object of the invention to provide lamps with which both a high relative luminous flux and a satisfactory colour rendition are obtained in the low range of colour temperatures (approximately 2600-4000 K).

According to the invention a lamp of the type described in the opening paragraph is characterized in that the wall load, defined as the quotient of power consumption and outer surface area of the part of the wall of the discharge vessel located between the electrode tips, has a value of at least 25 W/cm^2 , in that the ratio between the effective internal diameter ID of the discharge vessel and EA has a value in the range of $0.4 \leq ID/EA \leq 0.9$, ID being defined as the square root of the quotient of the volume of the discharge space between the electrode tips and EA, and in that the ratio between the largest internal diameter \varnothing_i of the discharge vessel and EA is at most equal to 1.1.

The invention is based on the recognition of the fact that a satisfactory colour rendition is possible when sodium halide is used in the filling of a lamp if during operation of the lamp there is a strong broadening and reversal of the emission of the sodium in the Na-D lines which are located at 589.0 and 589.6 nm at very low partial Na-pressure. By broadening and reversal the Na-D lines assume the shape of emission bands, the short-wave band being shifted to shorter wavelengths and the long-wave band being shifted to longer wavelengths as the emission is more reversed. A measure of the reversal is therefore the distance $\Delta \lambda$ in nm between the maximum values of the Na-emission bands. The long-wave emission band of the Na is shifted to the red part of the spectrum,

which is very favourable for the colour rendition properties. It has been found that a better colour rendition, that is to say, a higher value of the average colour rendering index R_{a8} is obtained as $\Delta\lambda$ has a higher value.

5 The colour rendering index for deep red colours, R_9 , which is often negative to deeply negative in discharge lamps may assume positive values in lamps according to the invention if $\Delta\lambda$ is relatively high. The value of $\Delta\lambda$ at which given colour rendition properties are obtained is
10 still dependent on the lamp type and the lamp filling. Thus, in lamps having a low power consumption (for example, less than 100 W) lower values of $\Delta\lambda$ may generally suffice to obtain the same colour rendition properties as in lamps having a higher power consumption, because a higher mercury
15 pressure prevails in these low-power lamps so that an increasing Van der Waals broadening is an extra contribution, predominantly to the long-wave side of the Na-D lines.

It has been found that two conditions are to be
20 fulfilled for a strong broadening and reversal of the Na-D lines. In the first place a large contribution of Na-D emission is required. This involves a high sodium halide pressure and hence a high temperature of the coldest spot T_{kp} in the discharge vessel, for example, 900°C or more.
25 This requirement for T_{kp} excludes the use of quartz glass for the discharge vessel. In a lamp according to the invention a gas-tight, radiation transmitting ceramic material is therefore used for the wall of the discharge vessel. A very suitable material is aluminium oxide which is
30 usable in a densely sintered polycrystalline form and also in a monocrystalline form (sapphire). Other possible materials are, for example, densely sintered yttrium oxide and yttrium aluminium garnet. The said high values of T_{kp} are attained in a lamp according to the invention by dimensioning the discharge vessel for a given power consumption during operation in such a manner that the wall load has a value of at least 25 W/cm^2 . The wall load is
35 defined as the quotient of power consumption and surface

area of the discharge vessel, considering only that part of the outer surface area of the discharge vessel that is located between the electrode tips.

The second condition which is to be fulfilled to obtain a sufficiently high $\Delta \lambda$ is that the actual discharge arc in the discharge vessel is to be surrounded with a sufficiently thick layer of Na-atoms in the fundamental state. This means that the discharge vessel must fulfil given geometrical requirements, notably a relatively wide discharge vessel is necessary. In a lamp according to the invention the ratio between the effective internal diameter ID of the discharge vessel and the electrode distance EA has a value in the range of $0.4 \leq ID/EA \leq 0.9$. ID is herein understood to mean the square root of the quotient of the volume of the discharge space between the electrode tips and EA. It has been found that also in lamps having a discharge vessel deviating from the cylindrical shape a thick shell of Na-atoms in the fundamental state is formed around the discharge arc such that a strong reversal of the Na-D lines is possible if the above-mentioned condition of ID/EA is fulfilled. A lamp as shown in the United States Patent Specification 3,363,133 already referred to above has an ID/EA value of approximately 0.25. It has been found that for ID/EA values of less than 0.4 a too small $\Delta \lambda$ is obtained and therefore a too low R_{a8} value. ID/EA values of more than 0.9 are not used because at such values T_{kp} easily assumes a too low value. Experiments have also shown that a further condition is to be imposed as regards the largest internal diameter \emptyset_i for lamps having a strongly curved wall surface of the discharge vessel, for example, ellipsoidal, spherical or approximately spherical lamp vessels. In fact, the ratio between \emptyset_i and EA must be not more than 1.1 because a too low T_{kp} is obtained at higher values, even if the condition for ID/EA is satisfied. For cylindrical discharge vessels ID is substantially equal to $0.89 \emptyset_i$ so that the condition for \emptyset_i/EA is always satisfied if the condition for ID/EA is satisfied.

In a preferred embodiment of a lamp according to the invention the distance between the electrode tips and the adjacent end wall parts of the discharge vessel is not more than half the largest internal diameter 5 ($\frac{1}{2} \theta_i$). In that case the required high value of the temperature of the coldest spot in the lamp can more easily be attained, generally also without extra steps for heat insulation of the lamp extremities.

The lamps according to the invention have the 10 advantage that for a given filling they have only a little spread in the colour point of the emitted radiation and also a very small variation of the colour point during their lifetime. A great advantage of these lamps is that they do not substantially show any colour variation when 15 varying the supplied power within fairly ample limits. It has been found that the effects of variations in the power counteract each other, in a sense, as a result of the relatively high sodium pressure and the lamp geometry used, so that a colour point stabilisation is obtained.

20 For the quantity of mercury which is used in the lamps according to the invention considerations apply that are analogous to the known metal halide-containing high-pressure mercury vapour discharge lamps. Generally the mercury quantity is mainly determined by the arc voltage 25 desired in the lamp. The mercury quantity will frequently be relatively low for lamps having a high power (for example at least 1 mg per cm^3 of the discharge space at powers of the order of 2000 W) and will increase with a decreasing power (to, for example 100 mg per cm^3 at powers 30 of the order of 10 W).

The filling of the lamps according to the invention comprises halides, preferably iodides, of sodium and of thallium. The sodium halide is present in excess, that is to say, unevaporated sodium halide is still 35 present during operation of the lamp. In practical lamps the sodium halide quantity is generally at least 10 μmol per cm^3 of the discharge space (for lamps having a higher power) and assumes larger values as the power decreases

(for example, to 500 μmol per cm^3 for the smallest lamps). In the lamps the thallium halide contributes in ... the form of the predominantly green thallium radiation so that white or substantially white light can be obtained in combination with the sodium radiation. Lamps are preferred which are characterized in that the molar ratio between thallium halide and sodium halide is at least 0.05 and at most 0.25. The lamps according to this preferred embodiment emit light at a comparatively low colour temperature, which is very much desirable for certain uses (for example, lighting for the living room and decorative lighting). The colour temperature is dependent on the Tl:Na ratio chosen and has values of approximately 2500 K (colour point slightly below the line of the black radiators and having a slightly yellow colour aspect) to approximately 15 3000 K (colour point slightly above the line of the black radiators and having a slightly green colour aspect). Lamps having a colour point which is substantially on the line of the black radiators have a colour temperature of approximately 20 2700 K.

A further advantageous embodiment of a lamp according to the invention is characterized in that the discharge vessel further comprises at least one halide of a metal radiating substantially in the blue or purple part of the spectrum, which halide, compared with sodium halide, has a high volatility and in which the molar ratio between this halide and the halides of Na and Tl combined has a value of up to 0.1 at a maximum. The use of blue or purple radiators provides the possibility of obtaining lamps having a higher colour temperature of the emitted radiation (higher than approximately 2700 K). To maintain satisfactory colour rendition properties, it is required for the halide of the blue or purple radiator to be used in relatively small quantities because otherwise the sodium halide is too much diluted so that $\Delta \lambda$ would be adversely affected. Therefore volatile halides are chosen (saturated vapour pressure at 900°C at least a factor of 10 larger than that of sodium iodide) in which the molar ratio between these halides and the halide of Na and Tl combined is not

more than 0.1 and preferably of the order of 0.01. In this manner lamps can be obtained having a high efficiency, a satisfactory colour rendition and a colour temperature of up to approximately 3200 K. Lamps of this type are 5 preferred which comprise at least one halide of at least one of the elements In, Sn and Cd because the best results are achieved with these halides.

A further preferred embodiment of a lamp according to the invention is characterized in that the discharge vessel also comprises at least one halide of at least one of the elements Sc, La and the lanthanides, in which the molar ratio between these halides and the halides of Na and Tl combined has a value of at least 0.02. The said elements Sc, La and the lanthanides have an emission consisting of many lines distributed over the entire spectrum with the centre generally being in the blue part of the spectrum so that these elements, if used only in a lamp, yield a colour point of the emitted radiation of > 5000 K. Consequently, with the lamps of this embodiment 10 as compared with the lamps comprising only Na and Tl higher colour temperatures can be attained whilst maintaining high luminous fluxes and very satisfactory 15 colour rendition properties. Values of the molar ratio between the halides of Sc, La and/or lanthanide and the halides of Na and Tl combined are then chosen to be at least 20 0.02 because then generally colour temperatures are attained of at least 3000 K. In fact, for colour temperatures of less than 3000 K the embodiments described hereinbefore with volatile, blue radiators are found to be 25 more advantageous. In these lamps having a colour temperature of 3000 K or more the use of at least one halide of at least of one of the elements Dy, Tm, Ho Er and La is preferred. With Dy lamps can be obtained having very high 30 values of R_{a8} and R_g and with colour temperatures of up to approximately 3600 K. The molar ratio between dysprosium 35 halide and sodium and thallium halide is then preferably 0.03 or more. With one or more of the elements Tm, Ho, Er and La it is possible to make lamps having colour tempe-

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ratures of up to approximately 4500 K, where the molar ratio between the halides of these lanthanides and the sodium and thallium halide is preferably chosen to be 0.04 or more.

5 Embodiments of lamps according to the invention will now be further described with reference to the accompanying drawing and a number of measurements.

10 The drawing shows in a cross-section a high-pressure mercury vapour discharge lamp according to the invention, intended for a power consumption of 160 W.

15 In the drawing the reference numeral 1 denotes the discharge vessel of a lamp according to the invention having a nominal power of 160 W. The discharge vessel 1 has a cylindrical wall part 2 of densely sintered polycrystalline aluminium oxide having a total length of 19 mm, an external diameter of 8.45 mm and an internal diameter of 6.85 mm. End wall parts 3, 4 and 5, 6, likewise of densely sintered aluminium oxide are sintered in a gas-tight manner to the respective ends of the part 2. These end wall parts consist of discs 3 and 5 having a thickness of 2 mm and projecting tubes 4 and 6, respectively. The projecting portion of the tubes 4, 6 has a length of 8 mm, an external diameter of 3 mm and an internal diameter of 2.05 mm. Tungsten pins 7 and 8 having a diameter of 0.2 mm are sealed in the tubes 4, 6, respectively, together with aluminium oxide packing pieces 17 and 18, respectively with the aid of a halide-resistant melting glass denoted by the reference numerals 9 and 10, respectively. The ends of the pins 7, 8 located inside the discharge vessel 1 constitute electrodes 11 and 12, respectively, with the tips 13 and 14 facing each other and are provided with tungsten electrode filaments 15 and 16, respectively (2 layers, 5 turns each of wire having a diameter of 0.3 mm). The distance EA between the tips 13 and 14 is 10 mm. The effective internal diameter ID of the discharge vessel 1 is 6.07 mm. The ratio ID/EA is therefore 0.6. (The largest internal diameter \varnothing_i is 6.85 mm and thus $\varnothing_i/EA = 0.685$). The distance between the electrode tips 13 and 14

and the end wall parts 3, 4 and 5, 6, respectively, is 2.5 mm. The contents of the vessel 1 are 0.55 cm^3 . For a power of 160 W the wall load of this lamp is 60 W/cm^2 . The discharge space within the vessel 1 contains an ionisable filling comprising mercury, argon as an ignition gas and halides. The discharge vessel 1 of the lamp is generally built in an outer envelope (not shown in the drawing).

EXAMPLE 1

A lamp having a construction as shown in the drawing was provided with 12 mg of mercury (approximately 21.8 mg Hg per cm^3 contents of the discharge vessel) and argon up to a pressure of 200 mbar. The lamp also contained 9.2 mg of a mixture of sodium iodide and thallium iodide, with the molar ratio between Na and Tl having a value of $\text{Na:Tl} = 92.5:7.5$. During operation of the lamp a relative luminous flux of 93 lm/W was measured at a power consumption of 160 W. The coordinates of the colour point of the emitted radiation were $x = 0.465$ and $y = 0.403$ and the colour temperature T_c had a value of 2565 K. For the average colour rendering index R_{a8} a value of 89 was found and for the colour rendering index R_9 a value of +20 was found. The distance between the maximum values of the Na emission bands, $\Delta \lambda$, was found to be 145 nm. Variation in the power consumption of the lamp proved to have little influence on the colour point. At a power of 150 W x was 0.466 and y was 0.404 ($T_c = 2560 \text{ K}$) and at a power of 175 W x was 0.464 and y was 0.403 ($T_c = 2570 \text{ K}$).

EXAMPLES 2 to 10.

Nine lamps having the same construction as the lamp of Example 1 were provided with an iodide mixture which in addition to the iodides of Na and Tl also contained an iodide of a blue radiator (indium, lanthanum or a lanthanide). Likewise as the lamp of Example 1 these lamps were provided with 12 mg of mercury, with the exception of Example 2 (10.1 mg Hg) and Example 9 (10 mg Hg). The following Table states for each Example the total mass M of the iodide mixture, the blue radiator used and the molar ratio of the iodides. Furthermore the Table

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states for each lamp the results of measurements at
a power consumption of 150 W. The relative luminous flux
 η (lm/W), the colour point x,y, the colour temperature
T_c (K), the colour rendering indices R_{a8} and R₉, and the
5 distance Δλ (nm) were measured.

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Examples	M (mg)	mol. ratio iodides	η (1m/W)	x	y	T_c (K)	R _{a8}	R ₉	$\Delta\lambda$ (nm)
2	7.85	Na:Tl:In = 92:8:6.4:0.8	73	0.438	0.390	2860	79	-54	54
3	8.1	Na:Tl:Dy = 75:6.2:18.8	93	0.393	0.364	3550	93	+52	89
4	7.0	Na:Tl:Dy = 72:14:14	97	0.409	0.386	3390	92	+31	78
5	6.17	Na:Tl:Dy = 84:12.8:3.2	100	0.430	0.394	3020	89	+ 2	84
6	9.4	Na:Tl:Ho = 80:10:10	97	0.415	0.395	3320	86	- 7	68
7	6.3	Na:Tl:Ho = 84:12.8:3.2	100	0.425	0.411	3250	83	-28	63
8	6.65	Na:Tl:Tm = 77:7:16	103	0.401	0.395	3600	87	+ 9	85
9	4.55	Na:Tl:Tm = 84:12.8:3.2	100	0.430	0.409	3150	80	-46	64
10	5.7	Na:Tl:La = 92:5.2:2.8	110	0.436	0.411	3070	82	-25	68

EXAMPLE 11.

A lamp having a construction as shown in the drawing, but intended for a power of 110 W was manufactured. The lamp had an external diameter of 6.0 mm, a (largest) internal diameter of 4.8 mm (effective internal diameter ID = 4.25 mm) and an electrode distance EA of 8 mm. The ratio ID/EA was therefore 0.53. The end wall parts consisted of a disc having a thickness of 3 mm and a projecting tube having an external diameter of 3 mm (length projecting portion 7 mm). The distance between the electrode tips and the respective end wall parts was 1.5 mm. The contents of the discharge vessel were 0.20 cm^3 . At a power of 110 W the wall load was 73 W/cm^2 . The lamp was provided with 5 mg of mercury (25 mg Hg per cm^3) and argon up to a pressure of 200 mbar. Furthermore 4.9 grams of a mixture of sodium iodide and thallium iodide (molar ratio Na:Tl = 92.8:7.2) was added to the filling. A relative luminous flux $\eta = 88 \text{ lm/W}$, chromaticity coordinates $x = 0.444$ and $y = 0.414$, colour temperature $T_c = 2970 \text{ K}$, $R_{a8} = 84$, $R_9 = -19$ and $\Delta\lambda = 91 \text{ nm}$, were measured on the lamp.

EXAMPLES 12 and 13.

Two lamps having a construction analogous to that of the lamp shown in the drawing, but intended for a power consumption of 40 W were manufactured. The external diameter of these lamps was 4.4 mm, the (largest) internal diameter was 3.5 mm (ID = 3.1 mm) and the electrode distance EA was 3.5 mm. The value of ID/EA thus was 0.69. The end wall parts had a disc having a thickness of 3 mm and a projecting tube having an external diameter of 2 mm (length projecting portion 3 mm). The distance between electrode tip and end wall part was 1.25 mm. The contents of the discharge vessel were 0.058 cm^3 . At a power of 40 W the wall load was 82 W/cm^2 . The lamps were provided with argon up to a pressure of 800 mbar, with mercury (Example 12: 2.89 mg; Example 13: 3.63 mg), and with a mixture of iodides of Na, Tl and In. The lamp of Example 12 contained 2.4 mg of this mixture in the molar ratio Na:Tl:In = 84.95:14.50:0.54. The lamp of Example 13 contained

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2.74 mg of this mixture in the molar ratio Na:Tl:In = 80.80:18.67:0.52. The following measurements were made at a power consumption of 40 W:

		Example 12	Example 13
5	η (lm/W)	78.5	70
	x	0.441	0.436
	y	0.378	0.399
10	T _c (K)	2715	2965
	R _{a8}	89	92
	R ₉	24	47
	$\Delta\lambda$ (nm)	129	141

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1. A high-pressure mercury vapour discharge lamp having a given power consumption during operation, provided with a discharge vessel having a wall of gas-tight, radiation transmitting ceramic material, said discharge vessel
5 enveloping a discharge space and being provided with an ionisable filling comprising a rare gas, mercury, sodium halide and thallium halide, an electrode being disposed within said discharge vessel in the proximity of each of two end wall parts, the electrode tips facing each other
10 being located at a mutual distance EA, characterized in that the wall load, defined as the quotient of power consumption and outer surface area of the part of the wall of the discharge vessel located between the electrode tips has a value of at least 25 W/cm^2 , in that the ratio
15 between the effective internal diameter ID of the discharge vessel and EA has a value in the range of $0.4 \leq ID/EA \leq 0.9$, ID being defined as the square root of the quotient of the volume of the discharge space between the electrode tips and EA, and in that the ratio between
20 the largest internal diameter \varnothing_i of the discharge vessel and EA is at most equal to 1.1.
2. A lamp as claimed in Claim 1, characterized in that the distance between the electrode tips and the adjacent end wall parts of the discharge vessel is not more
25 than $\frac{1}{2} \varnothing_i$.
3. A lamp as claimed in Claim 1 or 2, characterized in that the molar ratio between the thallium halide and the sodium halide is at least 0.05 and at most 0.25.
4. A lamp as claimed in Claim 1, 2 or 3, characterized
30 in that the discharge vessel furthermore contains at least one halide of a metal radiating substantially in the blue or purple part of the spectrum, said halide, compared with sodium halide, having a high volatility and the

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molar ratio between said halide and the halides of Na and Tl combined having a value of not more than 0.1

5. A lamp as claimed in Claim 4, characterized in that the discharge vessel contains at least one halide of at least one of the elements In, Sn and Cd.

6. A lamp as claimed in Claim 1, 2 or 3, characterized in that the discharge vessel furthermore contains at least one halide of at least one of the elements Sc, La and the lanthanides, the molar ratio between said 10 halides and the halides of Na and Tl combined having a value of at least 0.02.

7. A lamp as claimed in Claim 6, characterized in that the discharge vessel contains at least one halide of at least one of the elements Dy, Tm, Ho, Er and La.

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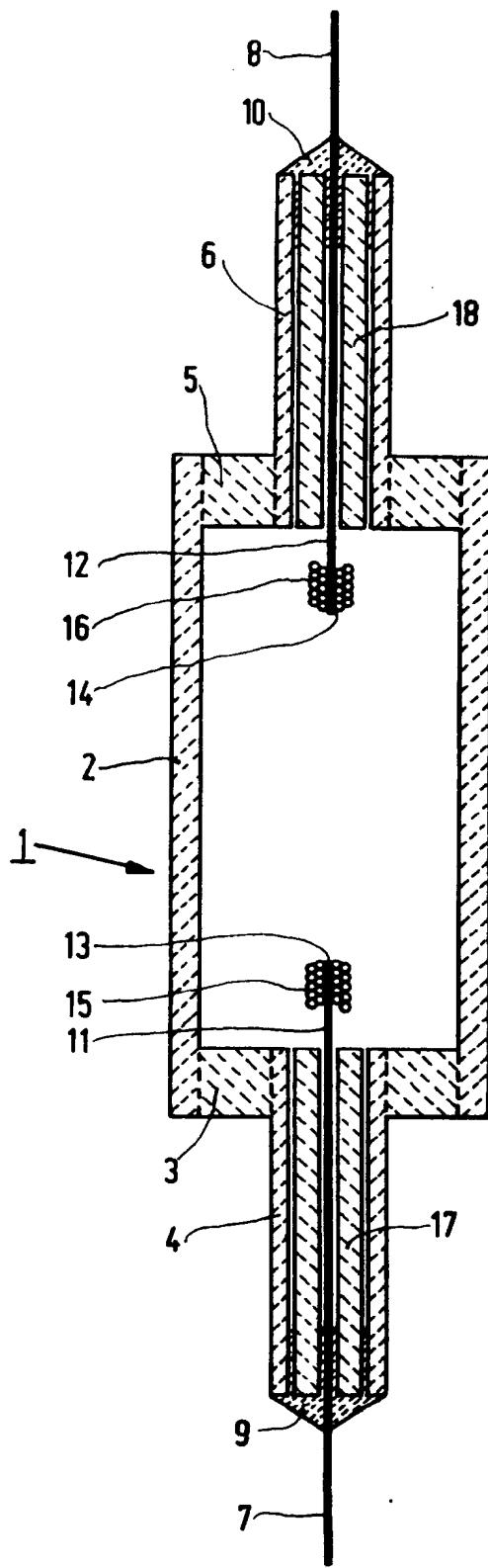
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EUROPEAN SEARCH REPORT

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EP 86 20 1561

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Y	GB-A-2 132 011 (PHILIPS) * Whole document * ---	1,2,4-6	H 01 J 61/30 H 01 J 61/82
Y	FR-A-2 089 504 (PHILIPS) * Whole document *	1-7	
A	TECHNISCH-WISSENSCHAFTLICHE ABHANDLUNGEN DER OSRAM-GESELLSCHAFT, no. 11, 1973, pages 163-175; A. DOBRUSSKIN et al.: "Halogen-Metallampen mit Seltenen Erden" * Paragraphs 1-4 *	1,4-7	
A	FR-A-2 130 255 (PATENT TREUHAND GmbH) * Page 1, line 28 - page 3, line 8; figure *	1,6,7	<p>TECHNICAL FIELDS SEARCHED (Int. Cl. 4)</p> <p>H 01 J 61/00</p>
The present search report has been drawn up for all claims			
THE EXAMINER		Date of completion of search	SARNEEL Examiner, T.
CATEGORY OF CITED DOCUMENTS			
X	particularly relevant if taken alone	T	theory or principle underlying the invention
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